METHOD AND APPARATUS FOR DISTRIBUTING ELECTRIC POWER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of United States Provisional Patent Application Serial No. **60/239,918**, filed **October 13, 2000**.

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention relates to methods, apparatus and systems for distributing electric power, and for distributing electric power to a load circuit from main and alternate electric power sources.

2. Description of Related Art

Increasing numbers of critical appliances or devices such as computers, alarm systems or heating/cooling systems are being employed in commercial buildings and residences. Many of these appliances and/or devices require a continuous supply of electrical power. Most residential and commercial buildings are wired for AC electric power supplied only from a single utility electric power source. In some areas this utility electric power source can be unreliable or expensive. Consequently, it is desirable to be able to use alternate sources of electric power as backup electric power sources to ensure a continuous supply of electric power or as less expensive electric power source alternatives.

Commonly, alternate electric power sources such as generators and inverters, for example, are wired to separate circuits and separate outlets or are used as alternate electric power sources to a conventional AC electric power

distribution panel normally supplied with electrical power from an electric power utility. Connecting individual appliances to separate circuits or separate outlets is impractical, as a user would have to connect each appliance to an appropriate outlet to receive electric power from either the main electric power source or the alternate electric power source, as required. Many generators, for example, have built in AC receptacles by which they supply electric power but can only accommodate a few appliances.

Alternatively, individual devices or appliances can be wired directly to a separate electric power distribution system which may be connected to a transfer mechanism operable to receive electric power from two AC electric power sources. This is often done where critical load circuits are to be backed up by an alternate AC electric power source. These load circuits are usually removed from the main electrical panel and wired into a secondary sub-panel. This sub-panel is then powered through a manual transfer switch or automatic transfer switch for controlling electric power supplied to the entire secondary panel. When AC electric power failure occurs from one source only those devices wired to the separate electric power distribution system are operable to draw electric power from the other AC electric power source.

The main disadvantage of the above system is that every device or appliance needing backup electric power must be wired to this special, separate electric power distribution system, which may require substantial re-wiring of circuits throughout a building. This has the additional disadvantage of limiting the locations the devices or appliances can be placed, and necessitates circuit re-wiring when devices or appliances are moved.

In addition, sourcing an entire AC electric power distribution panel with an alternate source requires the ability to switch large currents which mandates the use of expensive high current switching equipment. In conventional high current systems which provide for switching of an electric power distribution panel feed from a conventional high current AC source to an alternate source,

transfer speeds are relatively slow because of the large ampere ratings of the relays required to be actuated. Furthermore, the distance required between contacts of this type of transfer device increases proportionately to the current carrying capacity. Sub-panel transfer relays are relatively large and very slow, making them impractical for sub-panels supplying computers and process control equipment.

What would be desirable therefore is a simple way of extending an electric power distribution panel to provide for an alternate power supply to selected circuits, without rewiring of load circuits and without requiring high current switching capacity.

SUMMARY OF THE INVENTION

The above problems are addressed by providing a method for distributing electric power involving distributing electric power from an alternate electric power source to a plurality of selector sites and supplying power from the alternate electric power source or from a main electric power source to at least one load circuit, through a signal-controlled selector at at least one of the plurality of selector sites.

Distributing electric power may include conducting current on an electric power distribution conductor in proximity to the plurality of selector sites, where a base may support the conductor, the plurality of selector sites and a plurality of signal lines to carry control signals to respective signal-controlled selectors.

The method may also include providing at least one control signal for controlling at least one signal-controlled selector and supporting, on the base, a controller operable to produce the at least one control signal or a connector for receiving control signals from a remotely located controller.

The method may also include providing overload current protection to the load circuit when electric power is supplied to the load circuit from the alternate electric power source. This may be facilitated by providing a plurality of overload current protection mounting sites in proximity to corresponding selector sites to provide for mounting and connection of overload protection devices in series with the alternate electric power source and respective selector sites.

In accordance with another aspect of the invention there is provided an apparatus for distributing electric power to a load circuit from a main electric power source and an alternate electric power source. The apparatus includes a base, an electric power distribution conductor supported by the base for providing electric power from the alternate electric power source, and a load circuit selector site on the base and operable to supply power from the main electric power source and the electric power distribution conductor to a signal-controlled selector installed at the load circuit selector site.

The apparatus may further include the signal-controlled selector, which may be operable to selectively connect the load circuit to the main electric power source or to the electric power distribution conductor, in response to a control signal.

The base may have a plurality of selector sites to support a plurality of signal-controlled selectors and the base may support a plurality of signal lines for carrying control signals to respective signal-controlled selectors at respective selector sites.

The apparatus further may include at least one overload current protection mounting site on the base and associated with the at least one selector site to provide for mounting of an overload current protection device for, protecting the load circuit when electric power is supplied to the load circuit from the alternate electric power source. The overload current protection device may

be mounted at the overload current protection mounting site and may include a circuit breaker.

The apparatus may further include a signal-controlled selector operable to be received in the selector site for selectively connecting the load circuit to the main electric power source or to the electric power distribution conductor in response to a control signal.

The apparatus may further include a controller for providing at least one control signal for controlling the signal-controlled selector. The controller may include a processor circuit supported by the base, for example. The apparatus may also or alternatively include a connector supported by the base for receiving the control signals from a remotely located controller. Or the apparatus may include a wireless receiver or transceiver for receiving at least one control signal for controlling the signal-controlled selector.

In accordance with another aspect of the invention, there is provided an electric power distribution system including a first power distribution apparatus for distributing power to individual load circuits from a main power source, and a second power distribution apparatus adjacent the first apparatus, the second apparatus having a base, an electric power distribution conductor supported by the base for providing electric power from an alternate electric power source and a load circuit selector site on the base and operable to supply power from the main electric power source and the electric power distribution conductor to a signal-controlled selector installed at the load circuit selector site.

Using specific embodiments of the invention provided herein, the base may be mounted right beside an existing main electric power distribution panel, permitting load circuit wires to simply be removed from the main panel and moved a few inches (centimetres) to connect to the base. Thus, rewiring of load circuits is relatively simple and does not require a separate remotely located

subpanel as with conventional alternate supplies. Through use of the embodiments of invention described herein, the need to completely rewire panels in existing buildings to supply circuits with alternate sources of electric power is removed. In addition, the need for a secondary sub-panel in new construction is removed. Furthermore, use of such embodiments provides for safer installation by having only one place within a given building to disconnect a load from AC electric power and by ensuring that backfeed of electric power into the utility or into the alternate source cannot occur. Power transfer occurs at the load circuit level and therefore switching is done on currents of lesser magnitude which enables smaller components to be used in the selectors, such smaller components having less mass and requiring less spacing than higher current apparatus, resulting in faster transfer speeds, rendering embodiments of the invention more suitable for use with computers and process control equipment.

Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

In drawings which illustrate embodiments of the invention,

Figure **1** is a pictorial representation of a system for distributing power according to a first embodiment of the invention; and

Figure **2** is a pictorial representation of an alternate power distribution apparatus shown in Figure **1**.

DETAILED DESCRIPTION

Referring to Figure **1**, a system for distributing electric power is shown generally at **100**. The system **100** includes a first power distribution apparatus, which in this embodiment includes a main electric power distribution panel shown generally at **102** for providing electric power to individual load circuits from a main power source such as an electric utility supplier. The apparatus further includes at least one alternate power distribution apparatus such as apparatus **104** or **106** respectively, each for distributing electric power to at least one load circuit from the main electric power source, through the conventional main electric power distribution panel or from an alternate electric power source such as a power conversion device or generator, for example. The power conversion device may include an electric power inverter, for example. In this embodiment, the apparatuses **104** and **106** are located on opposite sides of and adjacent to the main electric power distribution panel **102**. Thus, close proximity of apparatuses **102**, **104** and **106** makes it easy to simply transfer load circuit terminations from the main electric power distribution panel **102** to new terminations on the alternate power distribution apparatuses **104** and **106**, as will be seen below. This eliminates the need to rewire or splice existing load circuits and ensures that all electrical power distribution connections are located at or adjacent to the main electric power distribution panel **102**, maintaining the focus of electric power distribution at or about the main electric power distribution panel and desirably not distributed about a premises. The apparatuses **104** and **106** could however be located away from the main electric power distribution panel **102**, but this would usually require splicing extensions onto the load circuits.

Referring to Figure **2**, in this embodiment, each apparatus such as apparatus **106** includes a base **110**, an electric power distribution conductor **112** supported by the base for providing electric power from the alternate electric power source, and includes a load circuit selector site such as site **130** on the

base operable to supply power from the main electric power source and the electric power distribution conductor **112** to a signal-controlled selector **114** installed at the load circuit selector site.

In this embodiment, the base **110** is formed from a printed wiring board on which is printed a plurality of copper electric power distribution conductors or traces, two of which, **112** and **116**, act as an electric power bus **118** for supplying electric power from an alternate source. Each electric power distribution conductor **112** and **116** may be connected to a separate phase (line) of an AC supply, for example. This facilitates use with multiple phase supplies, such as three-phase supplies, for example. Referring to Figure **1**, neutral conductors of the supply are connected to a neutral bus **127** of the main electric power distribution panel **102**. The copper traces **112** and **116** may be terminated at one end of the base, in a first set of first and second terminals, such as screw terminals **120** and **122**, to which wires (not shown) from the alternate electric power source may be connected to receive electric power from the alternate electric power source. The copper traces **112** and **116** may also be terminated at an opposite end of the base **110**, in a second set of screw terminals **121** and **123** to facilitate connection to an adjacent apparatus such as apparatus **125** shown in Figure **1**, to facilitate expansion of the electric power bus **118**, through the installation of additional apparatuses of the type described herein.

In this embodiment, the base **110** has a plurality of selector "sites" including the first selector site **130** and a second selector site **132** at which respective signal-controlled selectors, such as **114** and **115** can be installed to control the supply of electric power to respective associated load circuits. These sites may provide relay sockets, for example, or direct solder connections for mounting relays or other switching devices which may act as signal-controlled selectors operable to selectively connect the load circuit to the main electric power source or to the electric power distribution conductor **112** and **116**, in response to a control signal.

To do this, referring to Figures **1** and **2** each selector site **130,132** has a main terminal **134** for receiving electric power by means of a wire **135**, from a circuit breaker **136** housed in a circuit breaker receptacle of the main electric power distribution panel **102**. Each selector site **130** and **132** also has an output terminal **138** for terminating a conductor such as a wire **143** for providing electric power to a load circuit connected thereto.

Referring to Figure **2**, in this embodiment each selector site **130,132** further includes traces **141,143** on the base **110** from the main terminal **134** and the output terminal **138** respectively, terminated in pads or mounts **140** and **142** respectively, for connection thereto of a first contact and a common contact, respectively, of a signal-controlled selector **114** or **115** mounted at the site. In a direct current (DC) system, each electric power distribution conductor **112** and **116** may be connected to a separate or the same DC system pole, such as a positive (+) terminal and the opposite pole such as the negative (-) terminal may be connected to the neutral bus **127**. It would even be possible to connect an AC power source to one conductor **112**, for example and a DC power source to the other conductor **116**, for example to produce a hybrid system.

Each selector site **130,132** also includes a pad or mount **144** for connection to a second contact of the respective signal-controlled selector **114** or **115** and includes a trace **145** leading to a pad or mount **147** of an overload current protection mounting site **146** on the base and associated with the selector site to provide for mounting of an overload current protection device **148**. A suitable overload current protection device **148** may include a fuse or circuit breaker element, for example, which serves to protect an associated respective load circuit connected to the output terminal **138** from excessive currents supplied by the alternate source. Overload current protection is provided when the load circuit is supplied from the main source, by the circuit breaker **136** in the main electric power distribution panel **102**.

Each selector site **130,132** also has control and common coil pads or mounts **150** and **152** for terminating control and common coil contacts, respectively, of a signal-controlled selector **114** for supplying electric power to a coil **154** thereof. Circuit traces **156** and **158** extend from these pads and trace **158** is, in this embodiment, terminated at a contact **160** of a connector **162** supported by the base **110**, while trace **158** is connected to a common coil pad of each site and is ultimately terminated at a common contact **164** at the same connector **162**. Other circuit traces **166** similar to traces **156** extend from respective control pads of respective selector sites **130,132**, to respective contacts on the connector **162**.

The coils **154** or actuators of respective signal-controlled selectors **114** are controlled by signals received on respective pins of the connector **162**. Thus, the traces **156** and **158** act as a plurality of signal lines which are supported on the base **110** for carrying control signals to respective signal-controlled selectors **114**.

The coil **154** of any given signal-controlled selector **114** controls a contactor **168** thereof to selectively electrically connect the common contact pad **142** to either the first contact pad **140** or the second contact pad **144** to cause the common contact pad to be supplied with electric power from either the main electric power source or the alternate electric power source. Thus the coil **154** acts to selectively connect the load circuit to the main electric power source or to the electric power distribution conductor **112** in response to a control signal.

Signals for controlling respective signal-controlled actuators **154** may be provided by a controller **170**, such as a microprocessor control circuit, which selectively provides control signals for energizing respective signal-controlled selectors **114,115** to determine whether or not a respective corresponding load circuit is supplied with electric power from the main electric power

distribution panel **102** or from the alternate source supplying electric power to the electric power distribution conductor **112**.

In this embodiment, the controller **170** is mounted separate from the apparatus **106** and is operable to provide control signals through the connector **162**. The controller **170** may be a circuit on a power inverter, for example, located remotely from the electric power distribution system **100**. It should be noted that in an alternate embodiment the controller may be mounted on the base **110** such as shown in broken outline at **172**, and the control signal traces, or a subset thereof, may be connected directly thereto in which case the connector **162** may not be needed.

In another alternate embodiment, the connector may be replaced with a wireless receiver or transceiver for receiving wireless signals from a remote device for controlling the signal controlled selectors **114,115**. Such a wireless receiver or transceiver may be of the type provided under the trademark BLUETOOTH™ owned by Telefonaktiebolaget L.M. Ericsson of Sweden.

The apparatus **106** provides a convenient way of extending a main electric power distribution panel **102** into an electric power distribution system **100** which is operable to supply electric power from either a main electric power source or an alternate electric power source. As shown in Figure **1**, simply by mounting the apparatus **106** adjacent to an existing main electric power distribution panel **102**, wires from load circuits leading to the existing electric power distribution panel may easily be disconnected and connected to the output terminals **138** of respective selector sites **130,132** of the apparatus **106**. In addition, typically only two wires, a line and neutral wire, may be required to be run from the alternate electric power source to the apparatus **106** in order to distribute electric power to each of the selector sites **130,132** through the electric power distribution conductor **112**. Thus the apparatus may quickly be installed and operational in a relatively short period of time.

As stated above, the control signals, no matter how they originate or are received, determine which load circuits are to be supplied from the main or alternate power sources. This easily facilitates selective load sharing between power sources and may be used to isolate loads being supplied from different sources. In areas subject to brown-outs, for example, essential appliances may be supplied from the main or utility power source while luxury appliances may be supplied from the alternate supply.

While specific embodiments of the invention have been described and illustrated, such embodiments should be considered illustrative of the invention only and not as limiting the invention as construed in accordance with the accompanying claims.